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Productivity in U.S. Agriculture

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ABSTRACT

Productivity--output per unit of input--should not be confused with production--actual output--or productive capacity--potential output. The quantity and quality of resources employed (influenced by costs, prices, policy regulations, and management), as well as technological innovations emerging from research and development, influence productivity changes. Farm-sector productivity is generally increasing, although weather induces year-to-year variations. Productivity trends, both regionally and among commodities, differ significantly from national aggregates. Marketing-sector labor productivity has been more volatile than farm-sector labor productivity. Two measures of food-manufacturing-sector productivity demonstrate the effect of input quality on measured productivity.

Keywords: Productivity, agriculture, food marketing sector, crops, livestock, commodities.

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INTRODUCTION

Throughout the history of civilization, people have been concerned with the adequacy of their food supply. Wars, plagues, drought, pestilence, and instability from other sources have left a large part of the world's population on a razor's edge of malnutrition or starvation throughout much of recorded history.

The 18th century English economist Thomas Malthus formulated a scenario of world population rising more rapidly than food production, the result being chronic food shortages and, ultimately, starvation for millions.

Periodically, the Malthusian specter returns to haunt our minds and consciences as in the Sahel of Central Africa in the seventies, the Indian subcontinent in the mid-sixties, and worldwide in the early seventies.

The United States has escaped the Malthus scenario, and, in fact, throughout much of the past century, our production has exceeded our consumption. Slowly, but more rapidly during the seventies, the rest of the world has become increasingly dependent upon the United States as a source of food.

As we look to the eighties and nineties, questions arise as to our future production potential to meet what appears to be a sustained growth in exports of U.S. farm products. Much of the slack or excess capacity of U.S. agriculture has been taken up already. Further expansion of the cultivated area in the United States could, perhaps within this decade, become increasingly costly and accompanied with conservation and environmental problems. There are growing concerns about whether investment in agricultural research and development has been adequate to provide the technology needed to sustain agricultural production growth rates of the past several decades.

This brings me to the point of today's discussion: productivity trends and prospects for U.S. agriculture.

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*Presentation by Kenneth R. Farrell, Administrator, Economics and Statistics Service to the Joint Council on Food and Agricultural Sciences and the National Agricultural Research and Extension Users Advisory Board, February 18, 1981, Alexandria, Virginia.

PRODUCTIVITY: DEFINITIONS AND MEASURES

First, I wish to make clear the meaning of productivity as I will use it today. Simply put, it is a measure of the relationship between quantity of inputs (land, labor, tractors, and so forth) employed and quantity of outputs produced. An increase in productivity means that more outputs are produced by the same inputs, or the same outputs are produced with fewer inputs. Hence, this measure is a ratio of the growth of real outputs to the growth of real factor inputs.

Productivity is frequently confused with two other concepts: production and productive capacity. Production is the total quantity of outputs produced. Productive capacity is the amount of production which would be forthcoming if all the resources currently available to the industry were fully employed using the best available technology. The degree or extent to which productive capacity is utilized is often used as a measure of efficiency.

Productive capacity describes the possibilities at one point in time, but it is not fixed forever. The resources committed to, and the technology adopted by, agriculture respond to the economic incentives of price and profitability. In the long run, as real prices rise, production capacity increases.

Production is the total output of an enterprise, whether the farm, the crop sector, all of agriculture, or the entire Nation. Production is affected by the level of technology and the amount of resources used by that enterprise. Employing more resources will generally increase production.

Productivity, the output per unit of input in an enterprise, is affected by the level of technology and the mix of resources. However, employing more resources will not necessarily increase productivity. In fact, if technology and the amount of other resources used are held constant, increasing the use of one resource, say land, will usually decrease the productivity of that resource, because as area is expanded, lower quality (less suitable) land will have to be used eventually. It also makes a difference whether the next acre of soybeans is planted in, for example, Illinois or in North Carolina (a 15-bushel difference in yield).

Total output (or production) is determined by the total resources used in production and the productivity of those resources. I will focus just on productivity, although the ultimate question is: "What is our total productive capacity, considering both resources available for production and their productivity?"

Productive capacity will increase whenever either the available resources increase or the productivity of those resources increase.

Let me make a few comments on measures of productivity, measures we in ESS are responsible for producing within USDA. There are two major types: those which measure productivity of a single resource and those which measure productivity of a specified mix of resources taken as a whole.

The most commonly used single-factor productivity measure is labor productivity, the ratio of total production to total labor input, or output per hour of labor. Other widely used single-factor measures used in agriculture are yield per acre and production per animal unit.

An example of a total factor productivity measure is total farm output per unit of input, which measures the relationship between all factors used and total agricultural output.

In the farm production sector, there are three widely used measures of aggregate output: an index of crop production, an index of livestock production, and an index of total farm production. Both the crop and livestock production indexes are aggregates of individual commodity output indexes, each weighted by its relative value of production in a reference period (for example, 1967). Annual crop harvest and the liveweight of total animal slaughter are the output concepts, with adjustments to exclude producer goods (like seed production, hatching eggs, and milk fed to calves).

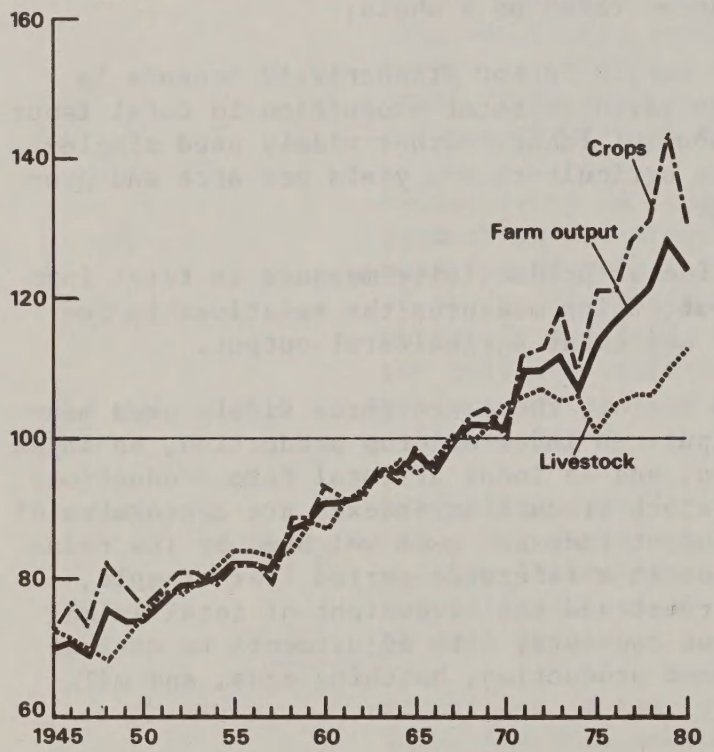
The total farm output index, similarly, removes the quantities of crops fed to livestock from the crop output index before aggregating it with the livestock production index. Thus, there are three conceptually distinct measures of farm sector output. Trends in these measures for 1945-80 are shown in figure 1.

Note that until 1970, all three series reflected similar trends. Since 1970, the increased crop production for export (and the corresponding crop price increases) caused the trends to diverge.

In order to draw appropriate inferences from the productivity measures, the input indexes must include the resources which constrain output. In crop production, the index of cropland used for crops contains the land area from which one or more crops were harvested, the cultivated summer fallow, and the area of crop failure. The index of animal breeding units is an aggregate of the beginning of the year inventories of breeding females by species, with weights for each species proportionate to the value of livestock production originating in that sector. The total farm input index is composed of indexes of farm labor, value of farm real estate adjusted for inflation, mechanical power and machinery, agricultural chemicals, the value added to feed, seed, and feeder and hatchery animals by the nonfarm economy, taxes and interest, and miscellaneous purchased inputs.

Figure 1

Total Output:
Crops, Livestock, Farm Sector



Period	Annual Growth Rate*		
		Production	
	Output	Crop	Live-stock
1945-50	1.1	0.8	0.5
1950-55	2.1	1.5	2.3
1955-60	2.1	2.5	.7
1960-65	1.5	1.3	1.8
1965-70	.6	.2	2.0
1970-75	2.4	3.8	-.8
1975-80	1.7	1.6	2.1
1950-60	2.1	2.0	1.5
1960-70	1.0	.7	1.9
1970-80	2.1	2.7	.6

*Point-to-point.

Our total factor productivity measure is the ratio of the index of the total farm output to the index of the total farm input.

Before looking at productivity as indicated by these measures, a few words of caution on their limitations, use, and misuse are in order.

Our data do not pick up changes in the quality of inputs or output; for example, changes in seed quality or wheat protein level.

Economists think in terms of four generalized factors of production--land, labor, capital, and management. The measurement of the management input (quality and quantity) is difficult. But we all know that quality of management is a key variable affecting the use of other resources and thereby productivity. Part of the measured changes of productivity necessarily reflect the differences in management.

Since our indexes reflect fixed combinations of inputs and outputs, the indexes may not precisely mirror the short-run situation on the farm. Farmers continually adjust the crop mix and input use depending on product price and input cost relationships. For example, there has been a long-run substitution of capital for land and labor. In the shorter run, farmers substitute among inputs and outputs depending upon their relative costs and expected prices for products. Since the relative importance of the products and inputs in our indexes is revised at about 10-year intervals, the indexes better reflect changes over the long- than short-term.

As you interpret single-factor productivity measures, such as labor productivity or yield per acre, remember that they measure relationships between one input and total output while the use of other inputs is also changing. Thus, any change in a partial measure of productivity can be misleading, unless the effects of other inputs have been identified. A further problem occurs if the input under study is not fully employed. Reducing the use of an underemployed resource can increase productivity of that resource without increasing production. Because all hours of farmwork are not equally critical to the production processes, the labor productivity trend in agriculture is not strictly comparable to labor productivity in the rest of the economy.

Weather and climate affect agricultural productivity to a greater extent than any other industry. A drought or an early frost, for example, can substantially affect production and thereby productivity as we measure it. Because of the variability of weather, and its influence on production, year-to-year changes in our productivity measures must be cautiously interpreted. A productivity index which corrects for climatic aberrations

would provide a better picture of the influences of technological innovations and better measures of productivity than we currently have.

PRODUCTIVITY TRENDS

I will discuss productivity trends primarily in terms of the changes occurring in the farm production sector, since information on productivity trends in the marketing sector is considerably more limited in scope.

Farm Sector Productivity

The farm sector has a remarkable history of productivity growth. Agricultural resources today are more than four times as productive as they were when the 13 Colonies banded together to form the United States 2 centuries ago. In 200 years, the predominant technology evolved from one which was powered by people to an animal-powered technology, to one powered by machines. Today, the growth of agricultural productivity is governed by the sciences--genetics, chemistry, biology--and by management.

Figure 2 illustrates these historical changes. In each succeeding epoch, the rate of productivity growth has accelerated, from a growth rate of less than 1/2 a percent per year, in the early years, to nearly four times that rate today.

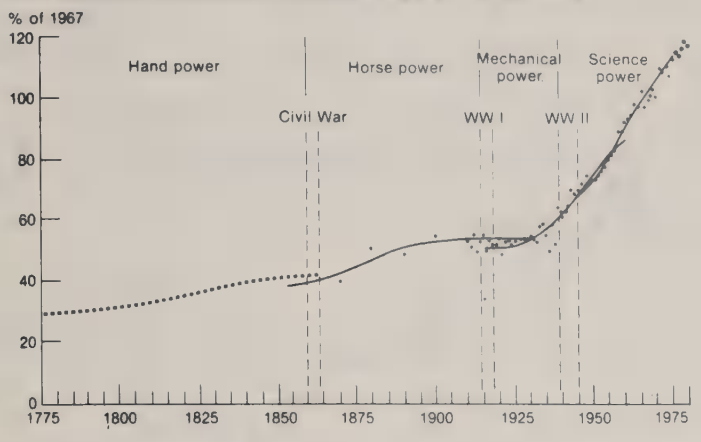
Figure 3 and table 1 present the trends of this measure since World War II. The data here suggest no major (or sustained) departures from a linear trend in this period, although there was more variation during the seventies. In such periods, the crop sector has a greater influence on the indexes. On a point-to-point basis, there has been a slight slowdown of productivity growth over the last 3 decades, but those observations were rather strongly influenced by such environmental factors as the 1970 corn blight and the 1980 drought.

Although the index of crop production per acre continued on its post-World War II trend with some weather related variations, livestock output per breeding unit declined dramatically after 1972 in response to high feed prices (figs.4 and 5 and table 2). The recovery of livestock productivity after 1976 masks a significant change--in each year from 1975 to 1979 the calving rate remained below 90 percent. This had happened only once before in the previous 25 years. The beef cow herd is not as productive as it has been historically. The livestock aggregate is increasing only in response to the greater importance of other livestock sectors such as dairy and poultry in the livestock production total.

The growth of crop production per acre at the national level conceals significant geographic differences in the productivity trends. The Midwestern and Western States which produce the bulk of crop output show trends of increasing productivity

Figure 2

U.S. Agricultural Productivity Growth During the Past 200 Years

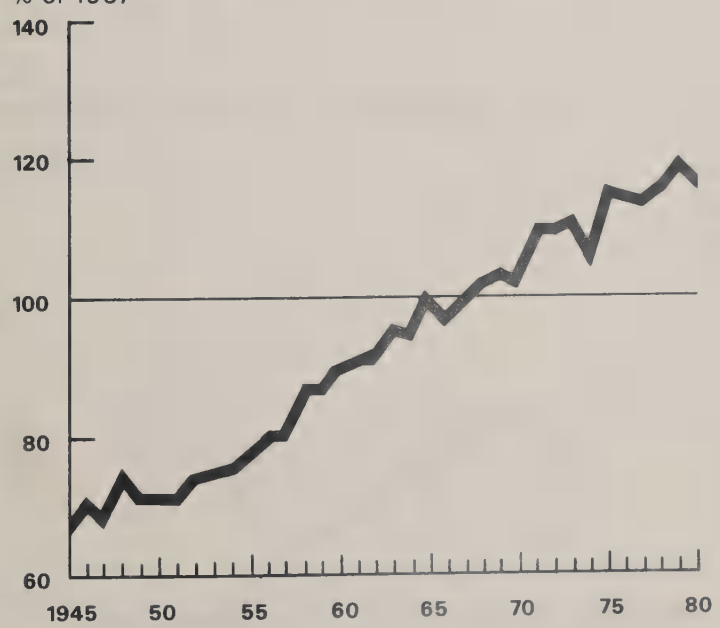


Period	Annual Growth Rate*
1975-1870	0.4
1870-1920	.5
1920-45	1.2
1945-80	1.6

*Point-to-point.

Figure 3

Total Farm Output per Unit of Input



Period	Annual Growth Rate*
1945-49	1.2
1950-54	1.4
1955-59	2.7
1960-64	1.8
1965-69	1.6
1970-74	.4
1975-80	1.8
1950-59	2.0
1960-69	1.7
1970-80	1.2

*Point-to-point.

Table 1--Indexes of total farm output, input and productivity

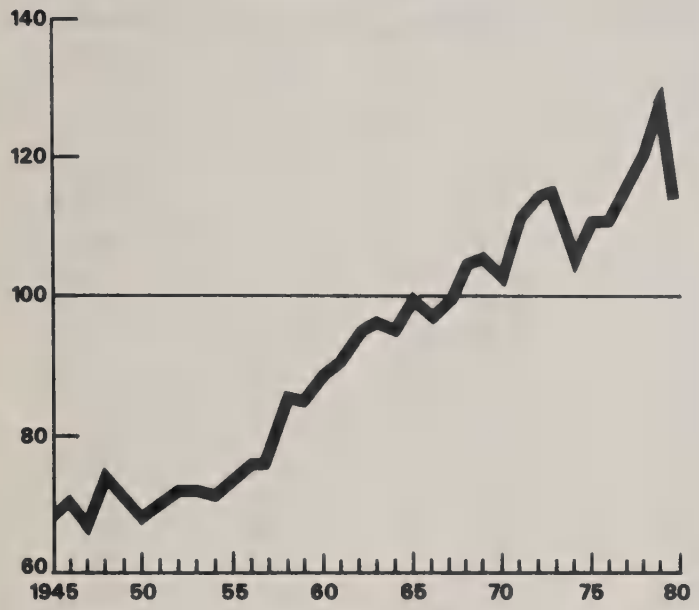
Year	Total farm output	Total inputs	Purchased inputs	Productivity	
				Per unit of total input	Per unit of purchased input
			1967 = 100		
1950	74	104	70	71	106
1951	76	107	73	71	104
1952	79	107	75	74	105
1953	79	106	75	75	105
1954	80	105	75	76	107
1955	82	105	76	78	108
1956	82	103	77	80	107
1957	81	101	77	80	105
1958	87	100	80	87	109
1959	88	102	84	87	105
1960	91	101	86	90	106
1961	91	100	87	91	105
1962	92	100	89	92	103
1963	96	100	91	96	106
1964	95	100	93	95	102
1965	98	98	93	100	105
1966	95	98	96	97	99
1967	100	100	100	100	100
1968	102	100	100	102	102
1969	102	98	101	103	101
1970	101	100	102	102	99
1971	110	100	105	110	105
1972	110	100	106	110	104
1973	112	101	108	111	104
1974	106	100	108	105	98
1975	114	100	107	115	107
1976	117	103	115	115	102
1977	119	105	121	114	98
1978	122	105	125	116	98
1979	129	108	132	119	98
1980	124	106	--	117	--

Source: USDA-ESS. Economic Indicators of the Farm Sector: Production and Efficiency Statistics, 1979; Statistical Bulletin No. 657, Feb. 1981.

Figure 4

U.S. Crop Production per Acre

% of 1967



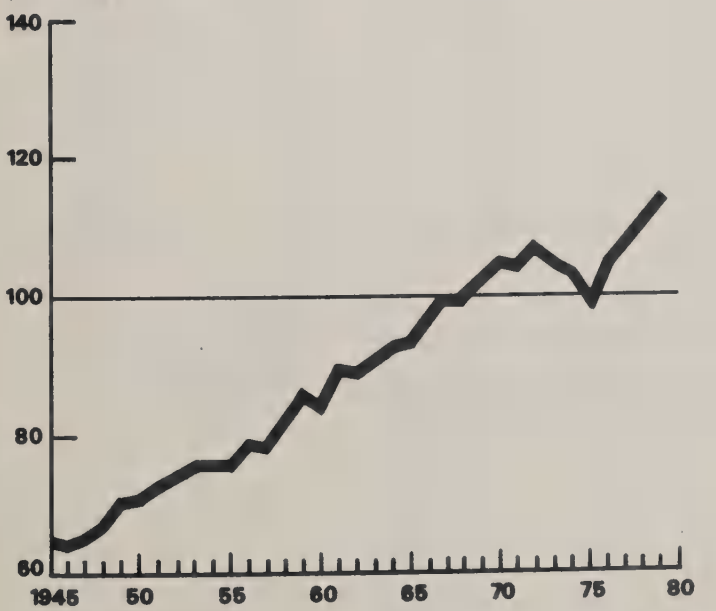
Period	Annual Growth Rate*
1950-59	2.7
1960-69	1.4
1970-80	1.2

*Point-to-point

Figure 5

Livestock Production per Breeding Unit

%of 1967



Period	Annual Growth Rate*
1950-59	1.9
1960-69	2.1
1970-79	1.1

*Point-to-point.

Table 2--Crop, livestock, and labor productivity in the farm sector

Year	Crops			Livestock			Labor
	Crop production	Cropland used for crops	Crop production per acre	Livestock production	Animal breeding units	Livestock production per unit	Persons supplied per farmworker
	1967 = 100						No.
1950	76	111	68	75	106	71	15.5
1951	78	112	70	78	107	73	15.8
1952	81	112	72	78	106	74	16.4
1953	81	112	72	79	104	76	17.2
1954	79	112	71	82	108	76	18.1
1955	82	111	74	84	110	76	19.5
1956	82	108	76	84	107	79	21.7
1957	80	105	76	83	106	78	22.7
1958	89	104	86	84	102	82	23.2
1959	89	105	85	88	102	86	24.5
1960	93	104	89	87	103	84	25.8
1961	91	100	91	91	101	90	27.6
1962	92	97	95	92	103	89	28.6
1963	96	99	97	95	104	91	30.7
1964	94	98	95	97	104	93	33.2
1965	99	99	100	95	101	94	37.0
1966	95	98	97	97	99	98	39.6
1967	100	100	100	100	100	100	42.1
1968	103	98	105	100	100	100	43.4
1969	104	98	106	101	99	102	45.1
1970	100	98	102	105	100	105	47.1
1971	112	100	112	106	102	104	49.2
1972	113	98	115	107	100	107	52.4
1973	119	103	116	105	101	104	55.0
1974	110	106	104	106	103	103	54.9
1975	121	108	112	101	102	99	57.6
1976	121	109	111	105	100	105	54.8
1977	129	111	116	106	98	108	59.8
1978	131	108	121	106	96	110	63.4
1979	144	111	130	110	97	114	67.9
1980	131	114	115	113	--	--	--

Source: USDA-ESS. Economic Indicators of the Farm Sector: Production and Efficiency Statistics, 1979; Statistical Bulletin No. 657, Feb. 1981.

(fig. 6). In contrast, crop production per acre in the States south and east of the Ohio River (including the Delta States) has not increased significantly since 1965 (fig. 7). The increased cultivation of marginal lands without solving the attendant problems of soil fertility, insect pests, crop varieties, and climate is the primary reason for this productivity plateau.

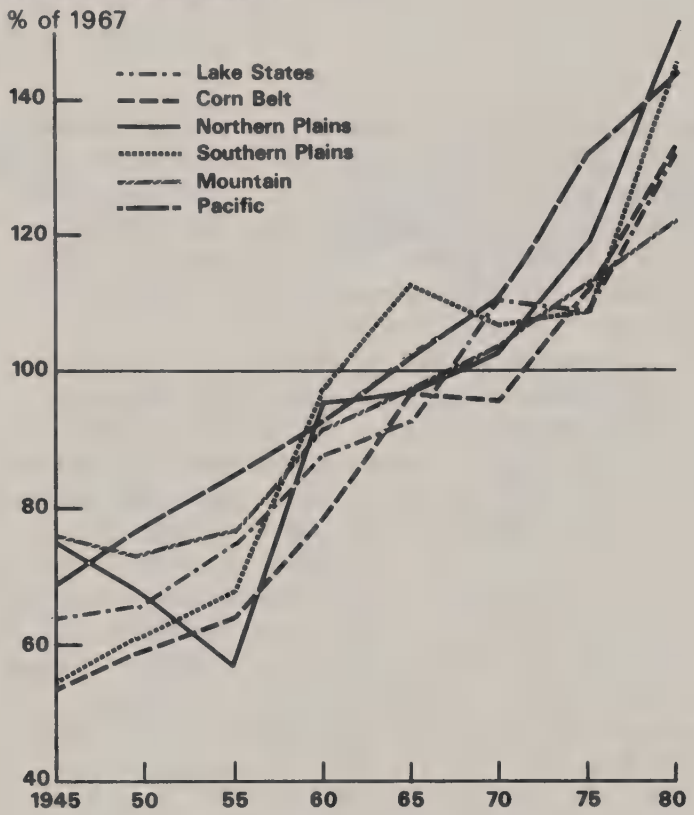
Individual Commodity Productivity

The crop sector has led the overall farm productivity index. Corn and soybeans have been especially important contributors to the growth in crop sector productivity. Corn yields now are more than two and a half times higher than in the early fifties as a result of the adoption of hybrid varieties. But the gains in productivity are not equally distributed. Corn yields in Illinois have continued upward with the national productivity trend, while yields in North Carolina and the Southeast generally have leveled off since 1965 (fig. 8). The same story is illustrated even more dramatically for soybeans. In fact, there appears to be a trend toward lower soybean yields in North Carolina apparently reflecting the increased planting on lower quality land (fig. 9). As figures 10, 11, and 12 illustrate, wheat, cotton, and rice yields show a similar pattern, with little or no increase in yields in the Delta States or Texas.

In the livestock industry, productivity gains take many forms: improved feeding efficiency (fewer pounds of feed per pound of gain), reproductive improvement (more pigs per litter), increased labor efficiency (fewer hours per milk cow), or better facilities utilization (year-round farrowing operations). The growth of the large confinement-type broiler "factories", made possible by antibiotic feed additives, is responsible for the phenomenal growth (better than 5 percent a year) in total ready-to-cook pounds of chicken produced per laying hen (fig.13). Similar forces have enabled egg production per hen to increase at the rate of 1 to 2 percent per year (fig.14). In the dairy sector, productivity increases have averaged 2.9 percent per year as a result of selective breeding programs and greater use of highenergy feed rations (fig.15). The development of confinement facilities in the pork industry enabled producers to moderate the seasonal pattern of production by allowing fall farrowings to to increase. The result of this change was to increase the annual pig crop per brood sow. In the cattle industry, the major innovation affecting productivity has been large-scale feeding operations which combine high-energy feed rations with a capital intensive operation to reduce both the growout time and the hours of labor required to produce beef. The prospect of twinning beef cattle is on the horizon to improve reproductive efficiency, but the liquidation phase of the cattle cycle has had greater effect on the overall calving rate than the technological improvements to date.

Figure 6

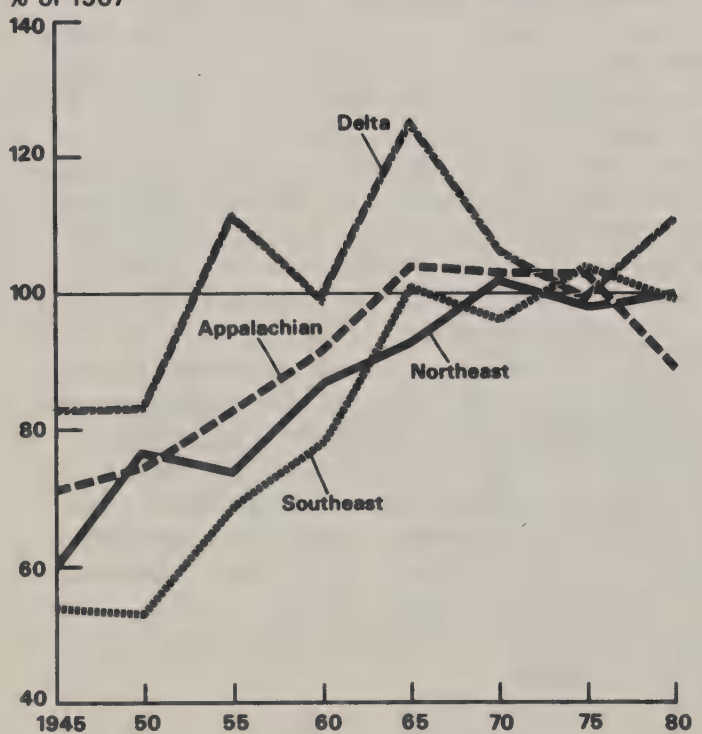
Crop Production per Acre, Midwest and West



Crop productivity in the Midwest and West characterizes the national productivity.

Figure 7

Crop Production per Acre, East and South



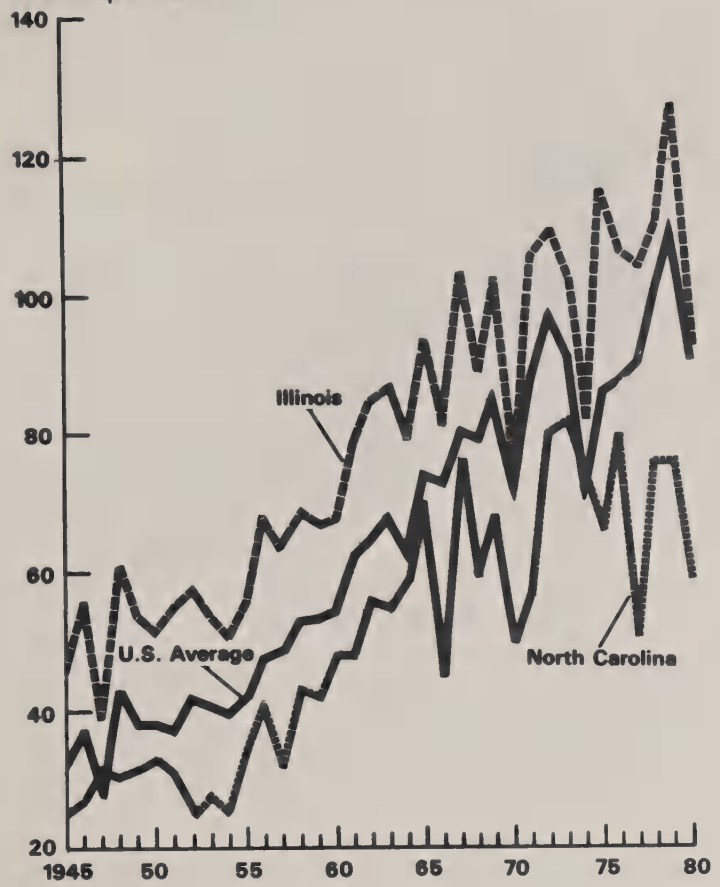
Productivity is not increasing in the Appalachian, Delta, Northeast, and Southeast Regions.

Converting marginal land to crop production is one cause. Soil fertility, insect pests, crop varieties, and climate factors are all parts of the problem.

Figure 8

Corn Yields

Bushels per acre



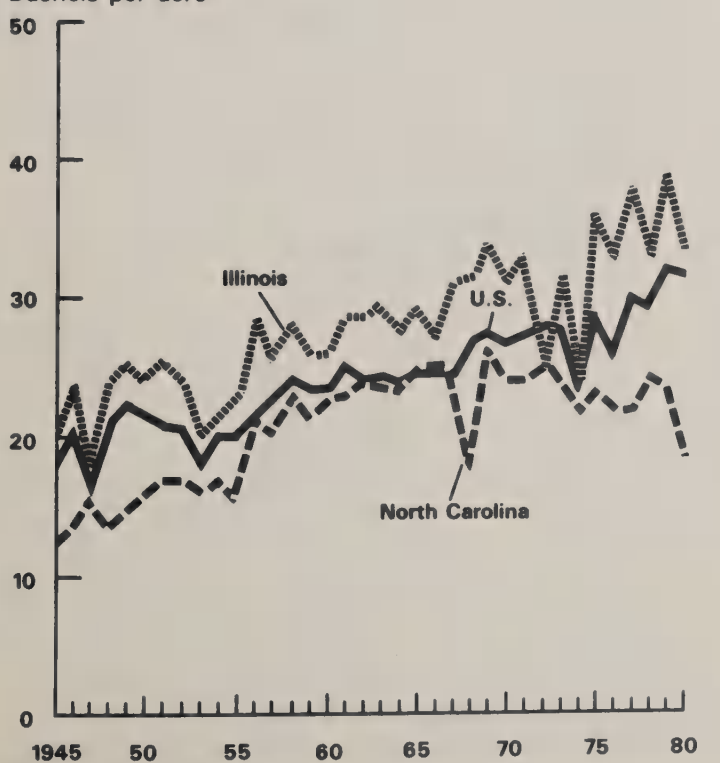
Period	Annual Growth Rate*		
	U.S.	Ill.	N.C.
1945-50	2.9	1.9	2.9
1950-55	.6	1.9	1.9
1955-60	4.7	3.9	5.3
1960-65	2.8	6.5	6.1
1965-70	3.0	-4.7	-.5
1970-75	-.1	9.0	3.5
1975-80	.8	-4.4	1.0
1950-60	3.6	2.9	3.7
1960-70	2.8	.9	.4
1970-80	2.3	2.3	1.8

*Point-to-point.

Figure 9

Soybean Yields

Bushels per acre



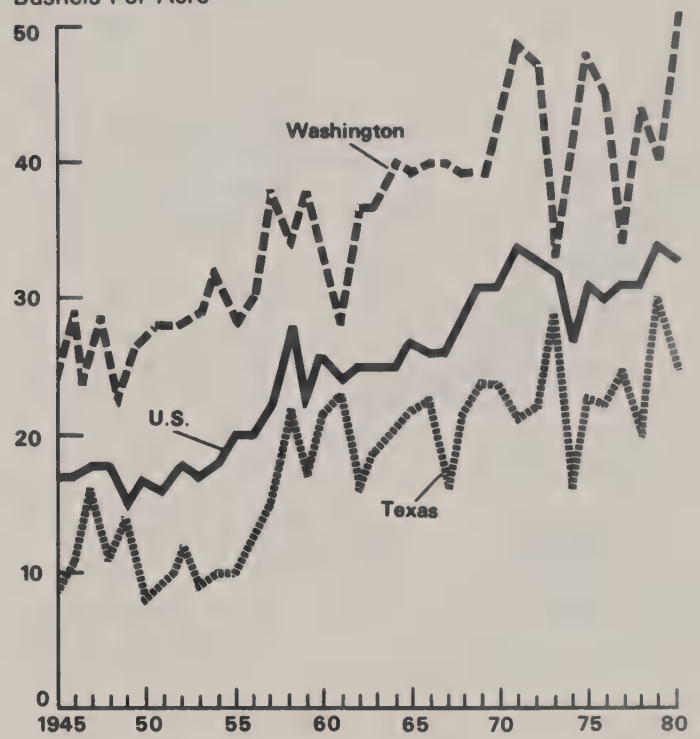
Period	Annual Growth Rate*		
	U.S.	Ill.	N.C.
1945-50	3.6	3.6	4.9
1950-60	1.1	.8	3.4
1960-70	1.2	1.8	.6
1970-80	.2	.8	-2.6

*Point-to-point.

Figure 10

Wheat Yields

Bushels Per Acre



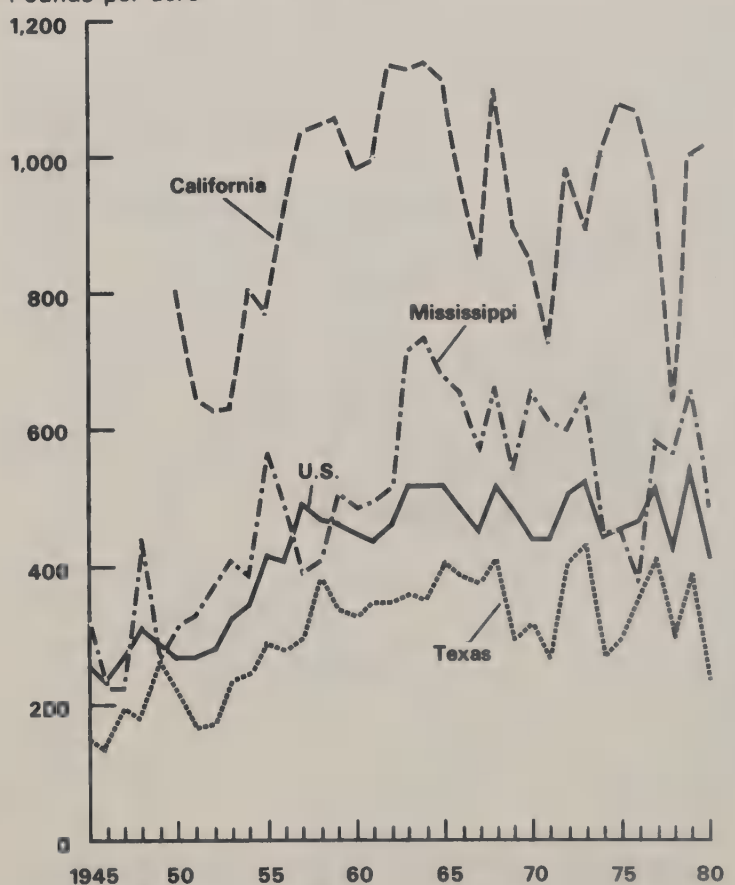
Period	Annual Growth Rate*		
	U.S.	Wash.	Tex.
1945-60	2.9	2.1	5.9
1960-70	1.8	2.8	.9
1970-80	.7	1.4	.4

*Point-to-point.

Figure 11

Upland Cotton Yields

Pounds per acre



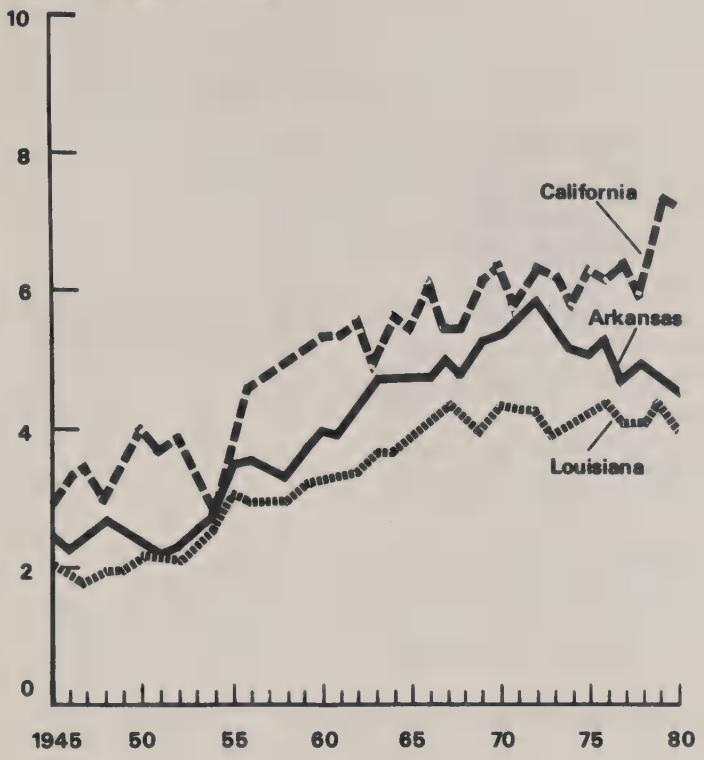
Period	Annual Growth Rate*			
	Cal.	Miss.	Tex.	U.S.
1945-60	2.0**	2.5	5.3	3.8
1960-70	-1.5	3.0	-.4	-.2
1970-80	1.9	-3.9	-2.9	-.7

*Point-to-point.
**Period is 1950-60.

Figure 12

Rice Yields

Metric tons per hectare



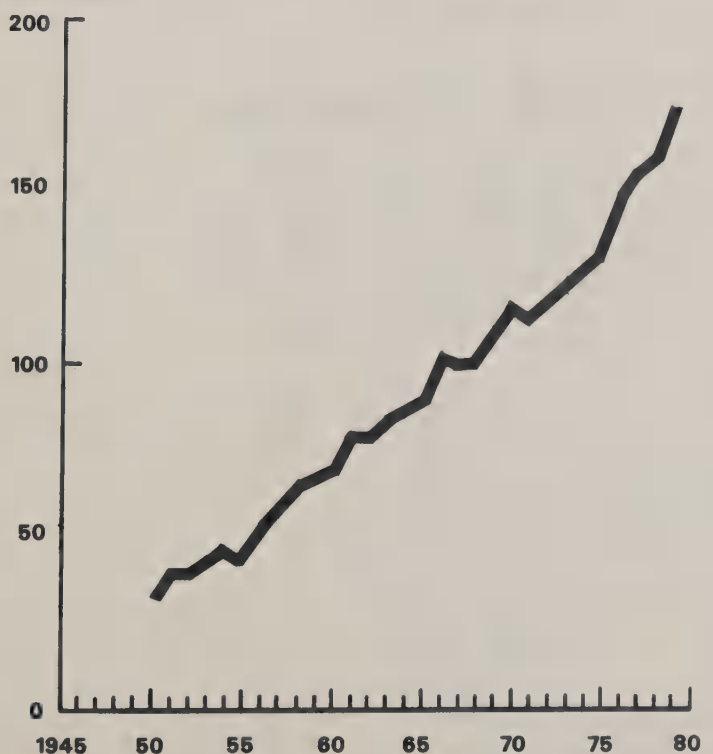
Period	Annual Growth Rate*		
	Cal.	Ark.	La.
1945-49	4.7	-0.2	-1.0
1950-54	-6.4	2.3	3.3
1955-59	5.7	1.6	.6
1960-64	1.1	3.6	2.9
1965-69	2.4	1.9	-.5
1970-74	-1.6	-.7	-1.4
1975-80	1.9	-1.7	-1.2
1945-60	3.9	3.4	3.1
1960-70	1.8	3.1	3.1
1970-80	1.2	-1.5	-.9

*Point-to-point.

Figure 13

Total Chicken Production per Laying Hen

% of 1967



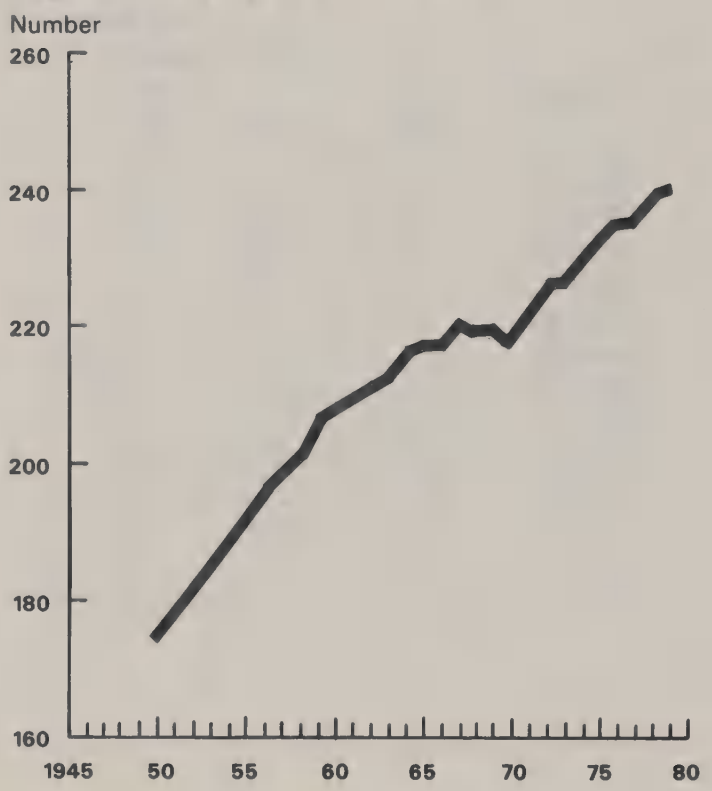
Index of pounds of ready-to-cook chicken meat produced per laying hen.

Period	Annual Growth Rate*
1950-54	7.2
1955-59	7.6
1960-64	9.8
1965-69	4.8
1970-74	3.3
1975-79	6.2

*Point-to-point.

Figure 14

Eggs per Laying Hen, January 1

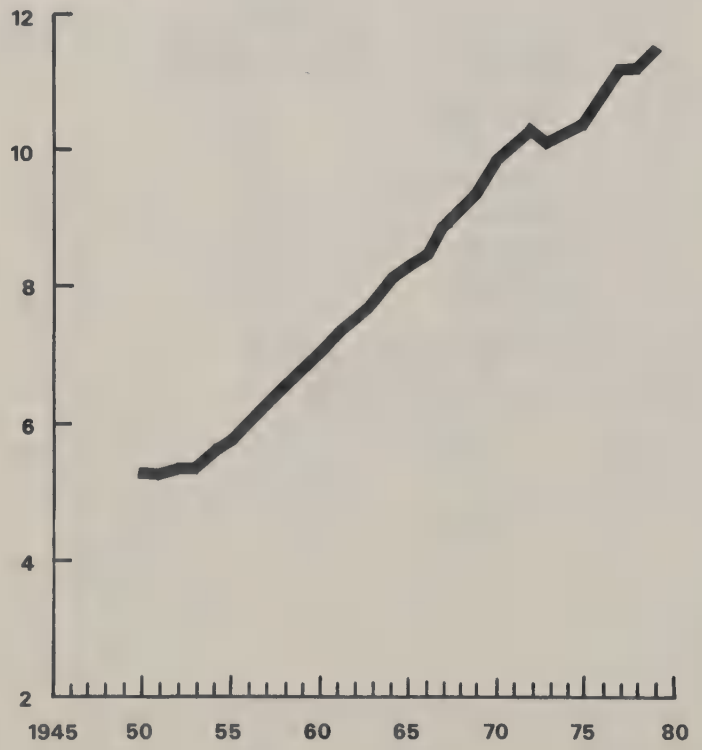


Period	Annual Growth Rate*
1950-54	1.9
1955-59	1.9
1960-64	.9
1965-69	.3
1970-74	.9
1975-79	.9

*Point-to-point.

Figure 15

Milk Production per Cow



Period	Annual Growth Rate*
1950-54	1.6
1955-59	3.7
1960-64	3.5
1965-69	2.5
1970-74	1.7
1975-79	2.2

*Point-to-point.

Table 3 presents the percentage changes in farm productivity from both a commodity and an aggregate perspective. Since these are calculated on a point-to-point basis, the influence of weather is apparent in some of the crop productivity measures.

Marketing Sector Productivity

For the food marketing sector as a whole, no general multifactor productivity measures are regularly reported which would give us the means to compare the performance in that sector with the performance of the farm sector. However, individual research projects occasionally develop multifactor measures for some part of the food marketing sector. Several years ago, researchers at the National Bureau of Economic Research (NBER) studied productivity changes in a number of manufacturing industries, including food manufacturing. 1/ At about the same time, some researchers in ESS were involved in a similar analysis of productivity in food manufacturing. 2/

The conceptual measures employed to represent the capital, labor, and output concepts were somewhat different in the two studies. The one methodological difference was that Gollop and Jorgenson (NBER) adjusted the input measures to reflect input quality improvements and intermediate products and Handy (ESS) did not. The result of that adjustment was to reduce the measured gain of productivity from about 3 percent a year (Handy's estimate) to a fraction of a percent (Gollop's estimate)(fig. 16 and table 4).

In the nonfarm economy, the most accessible single-factor measure of productivity which is comparable across industries is output per employee hour, reported by the Bureau of Labor Statistics (table 5). 3/ The output concept used is the contribution to gross national product (that is, valued added). Not all the industries which transport process, or distribute food products or which provide inputs to the farm sector are included in the reported statistics. However, enough detail exists to draw some inferences concerning relative performance at different levels in the food marketing system.

Figures 17 and 18 present estimates for 1960-79 of labor produc-

1/ Gollop, Frank, and Dale W. Jorgenson. U.S. Total Factor Productivity, by Industry, 1947-73. New York: National Bureau of Economic Research, 1975.

2/ Handy, Charles. Output, input and productivity indexes: food and related products, SIC 20, 201, 202, 203, 204, 205, 206, 207, 208, 209; unpublished data, 1977. National Economics Division, Economics and Statistics Service, U.S. Department of Agriculture.

3/ U.S. Department of Labor, Bureau of Labor Statistics. Productivity Statistics for Selected Industries, 1979 Edition, Bulletin No. 2054, December 1979.

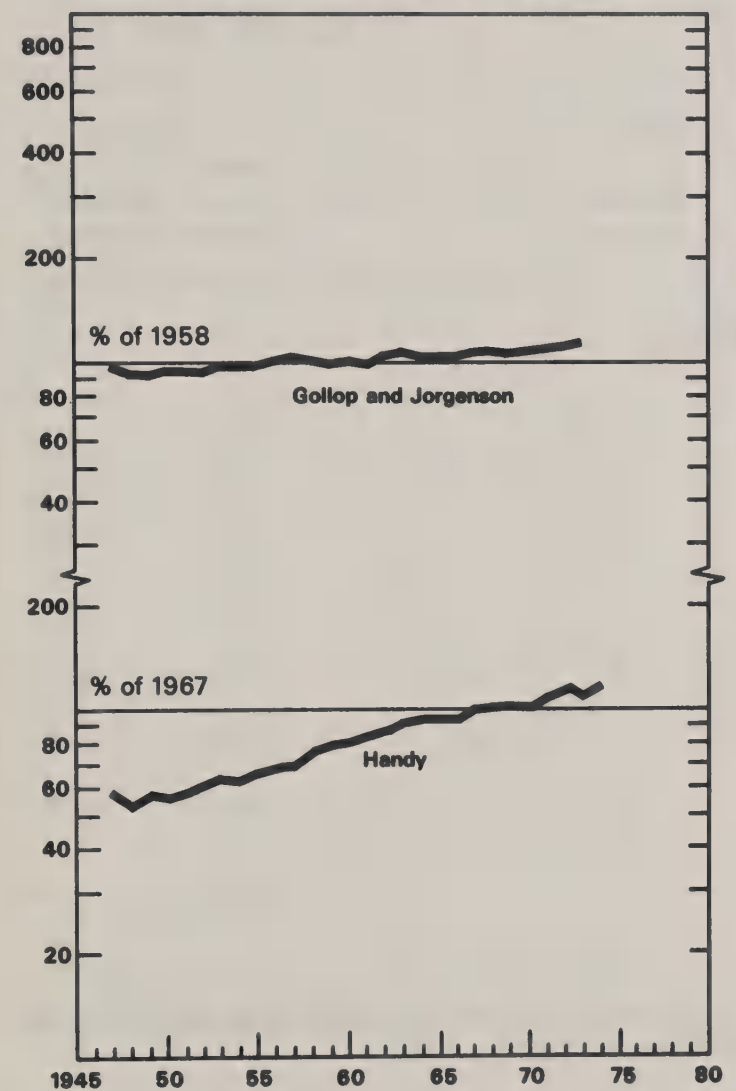
Table 3--Percentage change in selected measures of productivity, 5- and 10- year intervals, 1945-80 1/

Time period	Output per unit of output	Crop production per acre	Livestock output per breeding unit	Corn yield per acre U.S.	Soybean yield per acre U.S.	Milk production per milk cow	Eggs per laying hen	Chicken production per laying hen
				Percent				
5-year intervals:								
1945-49	1.2	0.3	2.7	2.9	3.4	NA	NA	NA
1950-54	1.4	1.7	1.4	.6	-2.2	2/1.6	2/1.9	7.2
1955-59	2.7	3.7	2.5	6.0	3.2	3.7	1.9	7.6
1960-64	1.8	2.3	1.6	3.4	- .6	3.5	.9	9.8
1965-69	1.6	.4	1.9	5.8	3.8	2.5	3	4.8
1970-74	.4	1.9	.2	-3.4	-2.9	1.7	.9	3.3
1975-80	1.8	.5	2.0	3/8.4	3/6.1	3/2.2	3/.9	3/6.2
10-year intervals:								
1950-59	2.0	2.7	1.9	3.3	.5	4/2.8	4/1.9	4/7.4
1960-69	1.7	1.4	2.1	4.6	1.6	3.0	.6	4.8
1970-80	1.2	1.2	1.1	4/2.4	4/1.6	4/2.0	4/0.9	4/4.7

1/ Data calculated as point to point rates of change.
2/ This is only a 4-year average, data for 1950 is not available.
3/ This is a 4-year average, data for 1980 is not available.
4/ 9-year average.

Figure 16

Multifactor Productivity in Food and Kindred Products Industry(SIC 20)



The difference in measured productivity increase is due to quality change in the set of inputs. Gollop and Jorgenson adjusted inputs to reflect increasing quality; Handy did not.

The better the production process is quantified, the smaller will be the residual growth attributable to pure "productivity change."

Table 4--Food and related products: Multifactor productivity indexes, annual rates of change

Time period	Gollop and Jorgenson 1/					Charles Handy 2/			
	Output	Intermediate goods input	Capital input	Labor input	Multifactor productivity	Output	Labor input	Capital input	Multifactor productivity index
	Percent								
1947-50	1.0	0.7	6.4	5.0	-0.7	1.0	-0.2	7.1	-1.0
1950-55	2.9	3.2	1.1	1.1	.2	2.9	-1.0	1.0	3.3
1955-60	4.3	4.5	1.5	-1.0	.7	4.3	.1	1.0	4.0
1960-65	2.4	2.5	2.3	.2	.3	2.7	-.9	2.0	2.8
1965-70	2.5	2.1	2.4	-.3	.8	2.3	-.5	3.2	1.9
1970-73	4.1	3.2	1.3	-.9	1.9	2.5	-1.5	2.9	2.8
1970-74	NA	NA	NA	NA	NA	2.9	-1.5	2.9	3.3

NA = Not Available

1/ Gollop, Frank, and Dale W. Jorgenson. U.S. Total Factor Productivity by Industry, 1947-1973; New York: National Bureau of Economic Research, 1975.

2/ Handy, Charles. Unpublished data: Output, Input and Productivity Indexes for SIC 20 and 3-digit subcodes; USDA Economics and Statistics Service, 1977.

Table 5--Indexes of output per employee-hour

Industry	Transportation		Processing			Distribution		
	Rail-road car-miles	Intercity trucking 1/	Fluid milk	Processed fruits and vegetables	Flour and other grain mill products	Bakery products	Retail food stores	Eating and drinking places
SIC CODE	401	4213pt	2026	203	2041	205	54	58
Year	1967 = 100							
1963	83.8	92.9	91.3	89.3	84.2	87.3	89.4	93.8
1964	86.7	95.3	93.1	92.1	88.7	90.1	91.4	92.8
1965	92.5	98.6	94.3	95.4	91.3	93.5	93.8	95.6
1966	97.3	104.0	97.0	94.9	96.9	94.6	96.3	97.4
1967	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1968	102.1	106.4	105.7	102.5	105.7	102.0	105.2	102.0
1969	104.5	109.0	110.6	104.4	103.3	102.3	106.1	100.4
1970	104.7	106.8	117.1	108.2	108.5	105.7	112.0	103.8
1971	108.2	113.6	126.2	112.6	110.0	108.1	112.7	100.9
1972	115.5	120.9	135.4	114.8	114.3	113.7	112.5	105.0
1973	119.2	123.4	140.1	125.6	113.7	113.1	108.1	105.9
1974	116.2	119.3	143.6	123.0	119.2	112.9	104.5	100.8
1975	115.5	114.1	150.3	124.9	120.8	112.7	104.8	102.0
1976	117.5	128.2	156.1	132.7	119.7	112.8	107.0	101.8
1977	117.5	127.9	156.1	131.9	140.3	120.1	106.4	98.9
1978	124.0	127.6	165.8	135.5	144.7	116.8	100.9	94.6
1979	122.6	126.1	174.7	NA	150.2	118.6	100.2	89.5

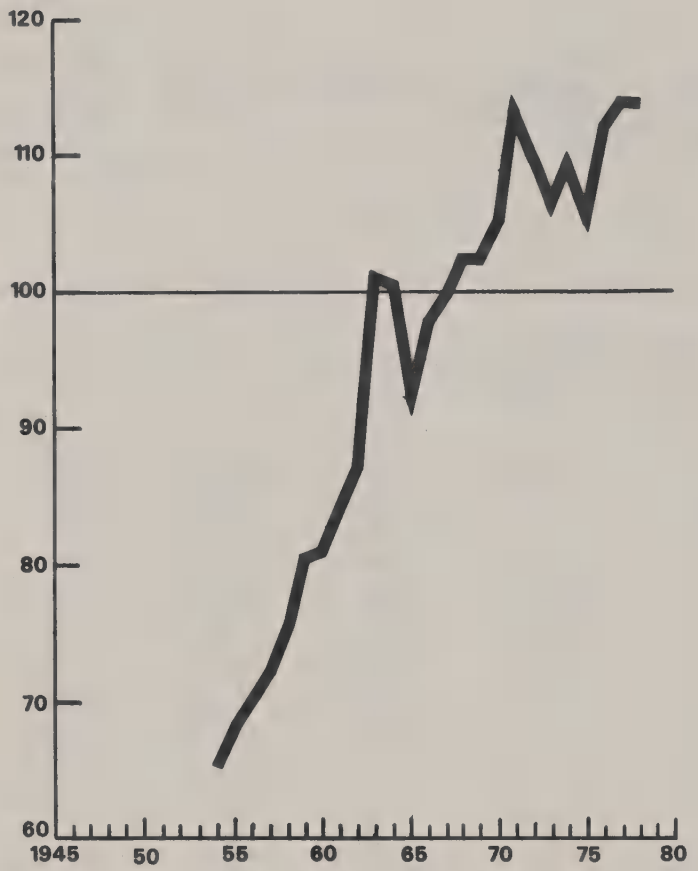
NA = Not available.

1/ Output per employee

Source: Bureau of Labor Statistics. Productivity Indexes for Selected Industries, 1979 Edition. Bulletin No. 2054, and USDL press release 80-804 (12/31/80).

Figure 17

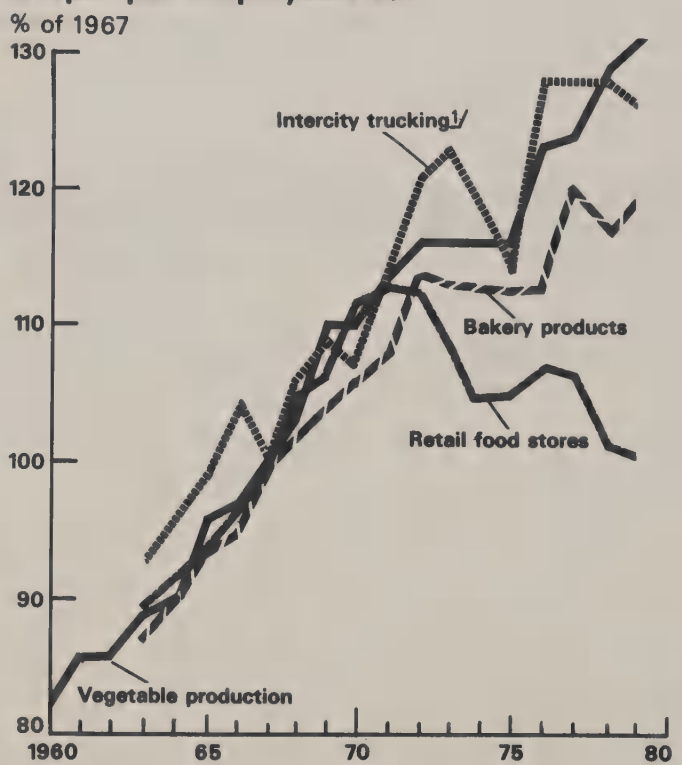
Output per Employee-hour, Meat Product Industry



Minimum work-week provisions of labor contracts contribute to the decline in labor productivity in meatpacking.

Figure 18

Output per Employee-hour



1/ Output per employee

The 55-mph speed limit curtailed productivity growth in trucking in 1973-75.

Longer store hours for the same sales volume are behind the fall in retail food store productivity.

Farm vegetable productivity continued to increase.

tivity in the meatpacking, trucking, milling, baking, and retail tail food industries, with farm vegetable production per hour as a comparison. Labor productivity in the vegetable production sector was chosen to represent the farm sector because hired labor is a significant and critical resource in that sector. (table 6). Labor productivity statistics for the farm sector as a whole tend to be somewhat misleading because of the existence of slack (underemployed) labor at many times of the year and over long periods.

It is clear that many changes occurred to labor productivity trends in the seventies. In the meatpacking industry, minimum workweek provisions in labor contracts increase the hours paid, and consequently reduced the output per hour of labor.

The trucking industry translated the 55-mile per hour speed limit into a productivity decline of nearly 10 percent between 1973 and 1975. Since then, longer and wider trailers, improved scheduling, CB radios, and increasing disregard of the speed limit have enabled this industry to restore some of its lost productivity.

The seventies saw a great increase in the number of two-income households. In order to increase the shopping convenience to families who work during the day, many retail food stores extended their hours, some to 24 hours a day. This spread an essentially fixed amount of sales over a greater time period, hence sales per hour and ultimately value added per employee hour fell. The effects of automated checkout systems are not yet observable on productivity in the retail food sector.

FACTORS INFLUENCING PRODUCTIVITY

In the preceding discussion, a number of factors were identified which have affected the productivity of resources in agriculture. Most of them exemplify the kinds of factors that will influence productivity in the future.

First and foremost is the quantity and quality of the resources themselves. The increases in crop yields per acre can largely be explained by greater use of fertilizer and agricultural chemicals. Irrigation development has improved quality of the land input and the quantity of the water input into western agriculture and narrowed the gap between Illinois and Nebraska corn yields from more than 20 bushels in the early fifties to near equality in the seventies.

Price and cost relationships affect the choice of commodities grown and the rates at which various inputs are used. Both prevailing prices and producers' expectations of future prices enter these decisions. High grain prices and the high cost of borrowed money reduced the demand for feeder cattle so much

Table 6—Labor: Indexes of farm production per hour by enterprise groups, United States, 1910-79

(1967 = 100)

Year	Farm output	Livestock and livestock products				Crops									
		All	Meat animals	Milk cows	Poultry	All	Feed grains	Hay and forage	Food grains	Vegetables	Fruits and nuts	Sugar crops	Cotton	Tobacco	Oil crops
1910	13	24	44	21	13	14	7	18	10	28	30	17	11	46	16
1911	13	24	44	21	14	13	6	17	9	27	35	18	13	46	19
1912	14	24	43	21	14	15	7	18	11	29	36	17	12	46	25
1913	13	24	44	22	13	14	6	17	11	27	32	18	12	45	18
1914	14	25	43	21	13	15	7	18	12	29	39	18	13	46	19
1915	15	25	44	22	13	16	7	18	12	28	39	17	11	46	18
1916	13	24	44	21	13	14	6	18	10	27	37	17	11	46	16
1917	14	24	43	21	13	15	7	18	10	28	35	16	11	46	14
1918	14	24	44	21	13	15	7	17	11	27	37	17	11	47	15
1919	14	24	45	22	13	15	7	18	11	28	38	16	11	44	13
1920	14	24	45	21	18	16	8	18	11	29	42	18	12	44	14
1921	14	24	45	22	13	15	7	18	11	29	32	18	10	44	13
1922	15	26	46	22	14	16	7	18	11	30	43	18	11	44	14
1923	15	26	48	22	14	16	8	18	12	30	43	18	10	45	17
1924	15	25	46	23	13	15	7	18	14	31	42	18	12	44	20
1925	15	25	46	23	13	15	8	18	12	29	40	20	12	44	19
1926	15	25	48	24	14	15	8	18	15	30	47	20	13	44	18
1927	16	26	48	24	14	16	8	18	15	31	40	21	12	42	21
1928	16	26	49	24	13	16	8	18	16	32	44	21	12	42	18
1929	16	26	48	25	14	16	8	18	16	32	43	20	12	43	17
1930	16	25	48	24	14	16	8	17	17	31	43	22	12	43	19
1931	17	26	48	24	14	17	8	18	19	33	50	20	14	44	15
1932	17	25	48	23	14	17	9	19	16	31	44	20	13	43	14
1933	16	25	48	22	14	15	7	18	13	32	45	21	13	43	13
1934	15	23	47	22	13	15	6	13	13	33	43	19	13	45	14
1935	17	24	46	23	14	18	8	19	14	33	50	21	14	44	21
1936	16	25	47	23	14	16	7	15	15	33	45	22	15	43	16
1937	18	24	47	23	14	19	9	20	17	34	53	22	17	45	19
1938	19	26	48	24	15	20	9	21	18	35	51	24	16	44	21
1939	19	27	49	24	15	20	10	21	18	35	56	24	16	45	25
1940	20	27	50	25	15	21	10	21	20	36	55	26	17	48	25
1941	21	28	50	26	16	23	11	22	23	37	58	26	17	46	26
1942	24	30	52	27	17	25	12	23	27	39	59	25	19	48	24
1943	24	31	55	27	17	24	12	24	25	40	55	23	18	46	24
1944	24	30	53	27	17	25	13	25	27	38	61	24	20	51	26
1945	26	31	52	29	18	27	14	27	29	41	58	25	19	50	26
1946	27	32	52	31	18	29	16	29	31	45	64	27	19	53	28
1947	28	33	52	32	18	29	14	31	35	47	64	30	22	52	31
1948	31	34	53	33	19	33	20	34	36	51	62	30	24	56	41
1949	32	35	54	34	20	33	20	37	34	50	66	34	28	55	49
1950	34	37	54	35	21	36	22	40	40	52	69	38	26	57	52
1951	35	39	56	35	23	35	23	42	38	55	70	39	28	58	58
1952	38	40	56	37	24	39	26	43	46	58	73	43	30	58	62
1953	39	41	57	38	27	40	27	46	44	59	76	48	34	58	65
1954	42	43	59	39	30	42	28	42	47	62	81	51	36	60	64
1955	44	46	61	42	32	45	30	46	51	65	78	53	39	65	69
1956	47	48	62	45	37	48	35	47	55	71	78	58	41	69	74
1957	51	50	63	48	39	53	40	51	62	74	72	66	44	66	75
1958	57	54	64	52	45	61	47	56	85	77	76	66	49	70	86
1959	59	58	67	55	49	61	52	59	78	81	77	75	53	69	90
1960	65	62	70	60	55	66	57	61	95	82	79	78	57	74	94
1961	67	66	73	64	61	68	63	64	87	86	83	81	61	76	99
1962	71	71	78	68	66	72	69	65	89	86	91	82	72	80	100
1963	77	77	83	72	73	77	77	66	91	89	92	96	78	83	101
1964	81	82	89	79	81	79	77	68	99	90	97	89	87	85	96
1965	89	86	89	87	87	90	91	85	101	96	98	88	102	92	104
1966	92	93	95	93	93	94	93	93	104	97	102	92	102	93	103
1967	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1968	106	105	104	108	104	106	102	103	110	103	101	110	133	101	111
1969	110	112	110	117	112	108	109	105	117	110	107	111	125	110	113
1970	115	121	117	125	119	111	109	105	121	110	109	116	136	129	127
1971	128	128	122	136	128	126	136	111	130	114	111	125	149	134	134
1972	136	137	130	148	142	135	153	120	124	116	109	127	187	149	144
1973	130	144	137	153	151	138	153	125	131	116	118	122	224	147	148
1974	136	156	147	168	166	128	131	124	115	116	129	118	208	158	134
1975	152	160	150	178	175	142	156	133	130	116	125	134	255	157	156
1976	162	178	164	202	200	146	164	128	127	123	129	139	302	164	150
1977	170	189	172	223	215	157	177	141	129	124	126	141	434	166	175
1978	182	204	186	242	241	166	199	155	136	129	129	145	439	179	170
1979	198	224	202	272	265	182	220	165	147	131	131	147	606	161	187

that the calf producers responded in a way which reduced both the production of calves and the productivity of cows.

Regulations and policies continue to affect production. USDA land diversion policies removed less-productive land from crop production and consequently raised the measured productivity of the sector. Numerous regulatory requirements of EPA, OSHA, and others have increased private costs without increasing output in those sectors.

The other factor which affects productivity is technology itself. Research and development have led to the introduction of hybrid corn and sorghum, have resulted in mechanical harvesting systems for many commodities, and have developed the veterinary medical means which permit raising large populations of fed cattle, hogs, and poultry in confinement facilities. Scientific research can lead to increased efficiency of the photosynthetic process of plants, biological fixation of nitrogen, and twinning in beef cattle. Many problems still exist: high-priced energy inputs call for the development of energy efficient technologies; and the stagnation of corn and soybean yields in the Southeast call for research on adaptive varieties and disease and pest control techniques.

Research and new technology will not, however, guarantee increasing productivity in the future. The economic incentives must exist, and the necessary information to evaluate and adopt the new technology must be available.

Economics and Statistics Service

The Economics and Statistics Service (ESS) collects data and carries out research on food and nutrition, international agricultural trade, natural resources, and rural development. The Economics unit researches and analyzes production and marketing of major commodities; foreign agriculture and trade; economic use, conservation, and development of natural resources; trends in rural population, employment, and housing and rural economic adjustment problems; and performance of agricultural industry. The Statistics unit collects data on crops, livestock, prices, and labor, and publishes official USDA State and national estimates through the Crop Reporting Board. Through its information program, ESS provides objective and timely economic and statistical information for farmers, government policymakers, consumers, agribusiness firms, cooperatives, rural residents, and other interested citizens.